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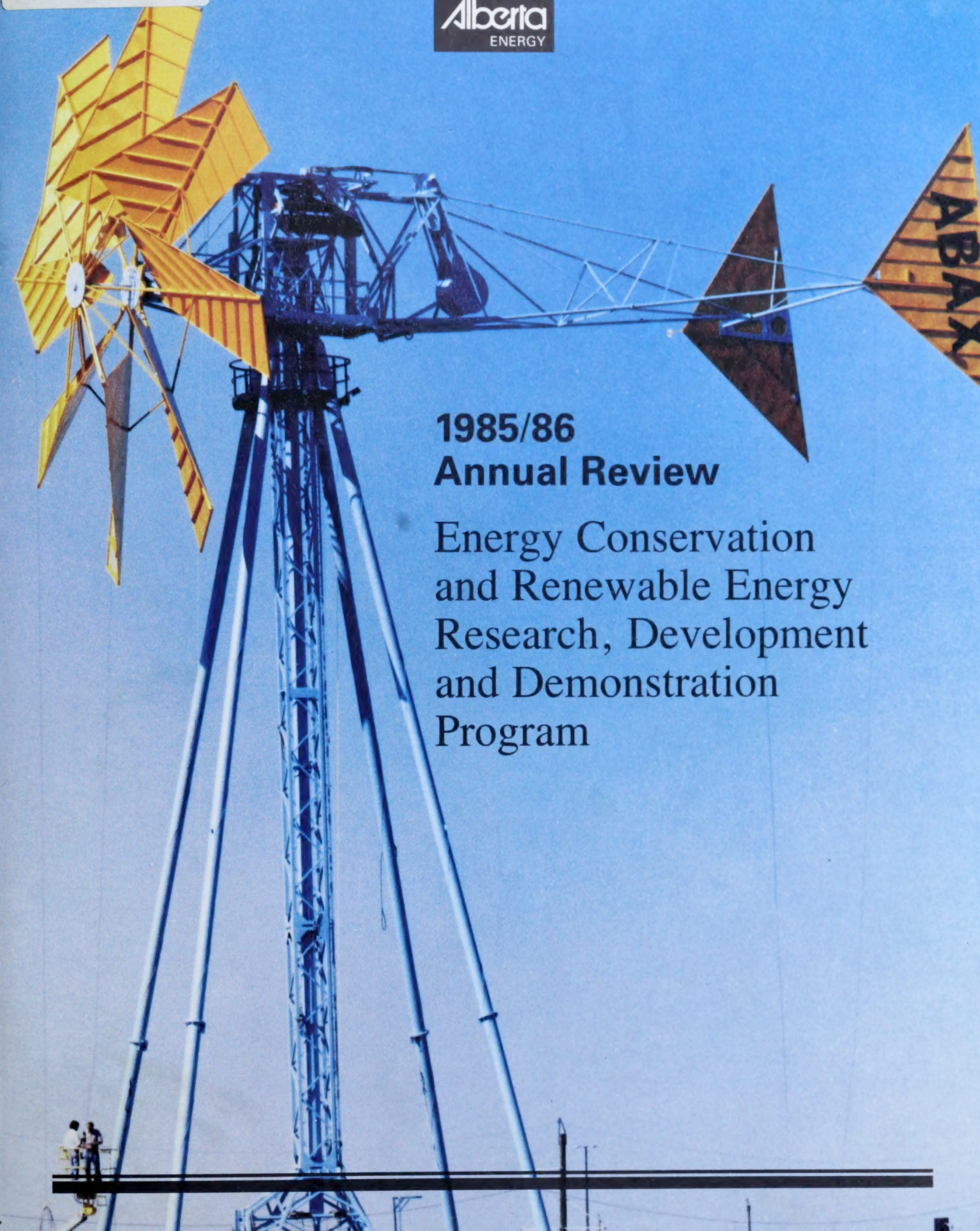

1985/86 Annual Review

Energy Conservation and Renewable Energy Research, Development and Demonstration Program

Cover Photo: A prototype delta-blade wind turbine, having 15 metre diameter blades, may be used in irrigation schemes or for other direct water pumping applications. It was built in Alberta with financial assistance from the Alberta/Canada Energy Resources Research Fund.

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1985/86
Annual Review

Energy Conservation and Renewable Energy Research, Development and Demonstration Program

Alberta
ENERGY
Scientific and Engineering
Services and Research Division

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Director's Report

Energy Conservation and Renewable Energy continues to be one of the priority areas for financial support and encouragement by the Alberta/Canada Energy Resources Research Fund (A/CERRF) Program.

Since the program began in 1977, there has been a steady growth in the number of funded projects and in the diversity of research topics that have been addressed. This has led to substantial subprograms focusing on energy conservation in buildings, wind energy and waste heat recovery. Also, in the last quarter of this year, a technology transfer project was initiated to lend support to past and present projects by disseminating research results to those who are best able to use them.

During fiscal year 1985/86, the program contributed a total of $699 843 to 38 active projects. The Energy Conservation in Buildings Subprogram was the largest, with 27 projects this year. In this subprogram, research efforts included several projects continued from last year which were aimed at energy conservation in residential buildings, such as retrofit demonstrations and development or testing of energy-efficient furnaces. This year, however, there were an additional 14 projects involving the development and demonstration of energy management and control schemes for commercial buildings such as office towers, warehouses and recreation complexes.

1985/86 was the final year of A/CERRF support for the Edmonton Energy Conservation Centre which successfully completed its first year of operation as an energy information and activity centre for the general public.

This was also the final year for several retrofit demonstration projects which quantified the energy and cost savings that are possible when certain changes are made to the components of existing dwellings; for example, sealing around doors and windows to reduce air leaks. While the costs of many of the suggested retrofits can be recovered in savings over a short enough time span to make them worthwhile, it is clear that the magnitude of energy and cost savings that result from such improvements is sometimes disappointing and can disappear altogether if homeowners are not prepared to alter their energy-consuming habits.

A new line of energy-efficient, gas-fired furnaces, which was developed specifically for Alberta's winter conditions, has found market niches in other parts of Canada and the United States. Other studies of energy-efficient furnaces showed that they save energy and consume less fuel than conventional furnaces, but people who purchase them should be aware that, depending on the particular furnace model, it may take from six to 18 years before incremental costs can be recovered in the form of fuel cost savings.

Studies have shown that wood frame construction techniques commonly used in Alberta produce dwellings that could be more energy efficient. Tests on a masonry wall housing unit showed that it experiences less air leakage than wood frame units, and the masonry wall unit can be heated with less fuel. This advantage is counter-balanced by higher capital costs to build masonry wall homes but estimates show that 10 years after construction the costs to own and operate either type of home are about the same.

For owners and managers of commercial buildings, several promising developments resulted from this year's research efforts.

Students and staff at Southern Alberta Institute of Technology developed computer software and novel, easy-to-use computer hardware to allow building maintenance personnel to simulate the operation of several major mechanical systems, in order to learn how they can be operated more efficiently and conserve energy at the same time.

A computerized building management system which can manage up to 99 remotely located controllers of mechanical equipment was conceived and developed in Alberta for use in large and small buildings. During a three month demonstration of the system in a multi-purpose commercial building, natural gas consumption declined by up to 50 per cent and electricity costs were reduced by 39 per cent.

Another device having potential for wide application in Alberta is a programmable controller designed to reduce electricity costs in outdoor parking lots. By responding to changes in the outdoor temperature and other factors, such as the time of day and the length of time vehicles are parked in the lot, the device allows electricity to be supplied intermittently to receptacles used to plug in automobile block heaters. This reduces energy consumption while allowing automobile engines to stay warm enough to be started without difficulty.

Within the Wind Energy Subprogram, the first year of a renewed three year wind turbine test program was concluded with a first attempt at studying wind pumping turbines during winter conditions. In general terms, this was not successful because of the severity of winter temperatures but one machine, the Deltx WP-20, manufactured in Calgary, operated long enough to show that it might be the most productive of all windpumps tested so far.

Although some mechanical difficulties have yet to be resolved with the 16-metre diameter prototype turbine made by Deltx Windpump Corporation, performance results obtained at low wind speeds demonstrated the considerable promise inherent in this new delta-blade design that originated in Alberta.

This year saw the beginning of a new subprogram aimed at recovery of waste heat and utilization of low temperature heat. Seven projects were initiated, four of which are applicable to commercial operations such as laundries, dairies and meat packing plants.

Another two investigations apply to buildings which are equipped with their own electricity generators from which heat might be recovered. The final study may provide valuable energy conservation information for operators of recreation facilities.

The Energy Conservation and Renewable Energy Research, Development and Demonstration Program continues to produce results that show Albertans how they can save energy using existing technologies and it is also providing opportunities for innovative researchers to develop new energy conservation systems that in some measure may help to diversify Alberta's economy while contributing to the national goal of energy self-sufficiency.

J.K. Kleta
Director
Energy Conservation and
Renewable Energy Research

Introduction

The activities of the Energy Conservation and Renewable Energy Program during fiscal year 1985/86 focused on three main research areas. They were:

Energy Conservation in Buildings

Wind Energy

Waste Heat Recovery/Low Temperature Heat Utilization

In addition, a technology transfer function was initiated this year to produce and distribute information booklets which summarize the results of investigations supported by the program.

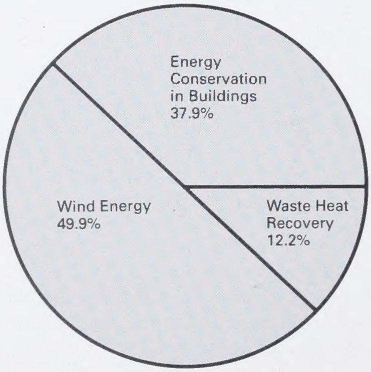
Funding for the program is provided through the Alberta/Canada Energy Resources Research Fund (A/CERRF), which was established as a result of the 1974 agreement on oil prices between the federal government and the producing provinces. The federal government pledged increased funds to strengthen and diversify Alberta's economy, including $96 million for energy-related research projects. Responsibility for applying and administering the fund rests with the A/CERRF Committee, made up of senior Alberta and federal government officials.

During 1985/86, research projects continued to build upon the efforts of previous years but they also expanded into one new area, waste heat recovery/low temperature heat utilization, in order to better address opportunities to conserve energy in Alberta and to develop alternative energy systems.

The following section, Review of Program Projects — 1985/86, provides detailed information about individual projects and their achievements while in Appendix A details can be found concerning the financial aspects of past and present projects.

Program expenditures this year amounted to $699 843 which were subdivided as shown in Figure 1.

Figure 1: A/CERRF Energy Conservation and Renewable Energy Program Funding Distribution (1985/86)



	Funding ($)	Percentage (%)
Energy Conservation in Buildings	265 478	37.9
Wind Energy	348 832	49.9
Waste Heat Recovery	85 533	12.2
TOTAL	**699 843**	**100.0**

Review of Program Projects 1985/86

The following project summaries describe the objectives and principal results of investigations partially funded by A/CERRF. Persons who require more details should contact the Director of Energy Conservation and Renewable Energy Research or the appropriate contractor(s).

Energy Conservation in Buildings

Edmonton Energy Conservation Centre

Tomorrow Foundation, Edmonton

The Edmonton Energy Conservation Centre is a 75 year old house that was renovated and retrofitted with a number of energy-conserving features and then made into a resource centre to permit demonstration and promotion of residential energy conservation measures. Since the Centre was opened in 1985, services such as product demonstrations, tours and workshops were made available to 1800 visitors. Also, a number of visual displays on such topics as insulation, air sealing and home heating systems has been prepared to educate visitors. Although the Centre initially relied on government funding, it is intended that it will generate its own revenue through marketing activities and product promotion services.

Energy Savings and Payback of Retrofit Basement Wall Insulations

Dow Chemical Canada Inc., Edmonton/Toronto

Extruded polystyrene sheathing was applied to the exterior basement walls of a Calgary home

Various insulation materials were applied to the interior or exterior surfaces of basement walls of four occupied homes in Edmonton, and one in Calgary, to determine retrofit costs, energy savings and cost-effectiveness based on lower heating bills. Installation costs ranged from $3200 to $3500 for interior work while exterior retrofits cost from $4200 to $4600. To date, energy savings at three homes have varied from two to 19 per cent as shown below:

Insulation Type & Location	**R-Value**	**Energy Savings**
Exterior, extruded polystyrene sheathing	12.5	2%
Interior, steel studs and glass fibre batts	12	15%
Exterior, rigid glass fibre	17	19%

Energy savings data for the remaining houses were not available this year because retrofit work was not finished in time to allow monitoring of a full heating season. This aspect of the study is continuing.

Because energy savings can be influenced by the habits of occupants, a concurrent study was conducted at the Alberta Home Heating Research Facility of the University of Alberta using unoccupied housing modules. These investigations have revealed that rigid polystyrene insulation (R10) applied to the exterior of a concrete basement wall reduced the cumulative below-grade heat losses by 60 to 70 per cent (and by 85 per cent for the above-grade portion of the wall) over a 16 month test period, thus indicating the theoretical energy savings that are possible using this approach.

Self-Help Retrofit Manual for Owners of Multi-Family Housing Units

Alternative & Retrofit Energies Ltd., Calgary

Under certain atmospheric conditions, condensation will reveal the location of heat lost through openings in a building's envelope

The selection of appropriate retrofit measures for multi-family dwellings is sometimes a difficult task because of the variety of available options. Alternative and Retrofit Energies Ltd. is preparing a step-by-step guide to assist unit owners and operators in choosing the best measures for their properties.

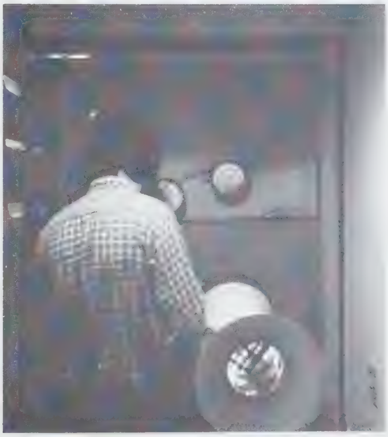
The guide will be based upon ongoing research involving a wide range of retrofit equipment and techniques which are being tested in a multi-family housing complex to determine how they affect energy consumption. Based on energy consumption patterns established over a four-year period, energy is being consumed in some units of the complex at twice the rate of the others. On average, the energy consumption rate is half that of similar-sized single family detached homes in Calgary.

Tests indicate that high-energy users could reduce their energy consumption by 32 per cent, compared to 19 per cent for average consumers, simply through education followed by lifestyle changes. While poor construction practices are blamed for high air leakage rates in the test homes, retrofit work performed by homeowners reduced air leakage rates by 40 per cent.

For each retrofit measure studied in this project, a separate, removable section is provided in the self-help guide. This allows information on individual subjects to be supplied to trade journals, newspapers or other interested parties in order to publicize the information widely.

Townhouse Retrofit Demonstration

Love Energy Consultants, Calgary



Airtightness of unoccupied homes was measured by depressurization fans inserted in door openings

Townhouses constitute 12% of the existing housing stock in Calgary, and it is expected that their proportion in future residential construction will increase because of the trend toward greater housing density. In order to develop a better understanding of the thermal performance of townhouses and potential retrofit measures, tests were conducted over the 1983/84 and 1984/85 heating seasons with two different pairs of townhouses. The units were left unoccupied to eliminate any overriding effects caused by occupancy. Tests and retrofit measures included air leakage and thermography measurements, basic air-sealing of the units, basement insulation, isolation of furnace rooms and monitoring of their effects on energy efficiency and performance.

Townhouses were found to be less airtight than single family dwellings of similar age. Where high air leakage rates were observed, payback periods of up to six years were required for basement insulation while basic sealing and isolation of furnaces required payback periods of two years. Air leaks occurred in places not mentioned in the retrofit literature and, because of their locations, homeowners would find it difficult to repair them. The project has been completed.

Energy-Efficient Housing Display Program

Alberta Home Builders' Association
(formerly HUDAC), Edmonton

Four years ago, 10 energy efficient homes were built in Edmonton and Calgary; five in each city. Since then, they have been sold and occupied. During two heating seasons the energy consumption and conservation performance of the houses were monitored using prototype digital monitoring equipment. Because difficulties were experienced in analyzing the collected data, completion of the project has been delayed.

Retrofit Wall Systems for Residential Housing

Alternative & Retrofit Energies Ltd., Calgary

One way to reduce air leakage and to improve wall insulation levels in older homes is to add a ''piggyback'' insulating wall on the exterior of the building. From a detailed survey of existing retrofit wall systems it was found that curtain walls and foamed polystyrene sheathing were the two most promising and cost-effective choices for installation by contractors and skilled homeowners. However, when the costs to remove the existing siding, and then apply the retrofit wall material and add a low-maintenance exterior finish were calculated, ($10.33/ft^2 and $9.90/ft^2 for curtain wall and polystyrene foam respectively) it was concluded that this type of retrofitting is cost effective only if the existing siding already needs to be replaced.

A Survey of Air Leakage in Alberta Homes

Bill Johnston Architect Ltd., Calgary

Air leakage rates were measured in 117 owner-occupied dwellings, which represented a cross section of Alberta's housing stock in terms of dwelling types, age and other characteristics. Ten homes were weatherstripped by homeowners and 20 were weatherstripped by a professional home sealing firm. Monitoring results showed that, on average, air leakage rates in the weatherstripped homes dropped by 19 per cent and natural gas consumption fell by 14 per cent versus patterns established prior to weatherstripping. The study identified significant potential for air leakage reduction and energy savings across a broad spectrum of housing types. It also showed that window and door frames are the most important components of homes to be sealed. As well, the relative benefits of various sealing techniques were identified. Average payback periods of 2.6 years apply to sealing work performed by homeowners, whereas it requires six years to achieve payback for work done by professionals. The information that resulted from this study should be of immediate benefit to both homeowners and contractors. The project has been completed.

Development of Higher-Efficiency Gas-Fired Furnaces

Flame-Master, Division of Bow Valley Industries, Edmonton

A power-vented unit heater was one of several higher-efficiency furnace products developed in Alberta

An Edmonton furnace manufacturer developed a new line of higher-efficiency gas-fired furnaces and suspended unit heaters that are made in Alberta and sold throughout Canada and the U.S. Not only did the furnaces achieve an effective seasonal efficiency of 80 per cent, compared with 55 to 60 per cent for standard forced air gas furnaces, but they were designed to operate in Alberta's high altitude and climatic conditions.

CGA certification was obtained for the furnaces, and significant numbers were successfully installed in British Columbia, Saskatchewan and Ontario as well as Alberta. Certification was obtained for a complete line of high-efficiency unit heaters and a small pilot run was assembled. Having achieved its objectives in this program, A/CERRF involvement was concluded.

Construction and Testing of a Masonry Module

Alberta Masonry Institute, Edmonton, and
I-XL Industries Ltd., Edmonton/Medicine Hat

When compared with a wood frame test home, a masonry wall unit experienced 40 per cent less air infiltration and showed a 21 per cent drop in energy consumption

It is estimated that 20 per cent of all the energy that is consumed in Canada is used for residential space heating. It has been proposed that the use of masonry walls instead of standard wood frame construction in Canadian homes may lower heating energy requirements. In order to demonstrate the concept, a double wythe wall masonry housing module was constructed at the Alberta Home Heating Research Facility of the University of Alberta in 1983 to compare it with a standard wood construction module. Each unit is the size of a double garage and has a full basement. Both units are unoccupied and are heated electrically under controlled conditions.

While insulation levels in the basement and ceiling were the same in both units, the measured R-value of the aboveground masonry wall was 26.7 versus 10 for the wood frame wall.

Subsequent monitoring showed that air infiltration through the insulated masonry wall was 40 per cent less than through the wood frame wall. Using the HOTCAN computer program, it was expected the masonry wall module would require about 90 per cent of the energy needed to heat the wood frame unit. Monitoring data showed that energy requirements were even less; only 79 per cent. The unexpected improvement is due to the ability of the masonry walls to store more heat and to release it over a longer period of time than is the case with standard wood frame structures. This means the masonry module stayed cooler during daytime heating periods and remained warmer as the outside temperature dropped at night.

Although the initial construction costs are higher for masonry walls than for conventional wood frame construction, it is expected that energy savings, lower insurance and maintenance costs and a more attractive appearance resulting from the use of masonry walls will more than compensate for any capital cost increase. Taking into account construction costs, operating costs and home resale values of wood frame dwellings versus comparable masonry wall structures, estimates of cumulative ownership costs 10 years after the homes are built showed the two should be nearly the same. The project has been completed.

Residential Air-to-Air Heat Exchanger Using Heat Pipe Technology

EMC Energy Management Consultants Ltd., Calgary

Prototype air-to-air heat exchangers using heat pipes configured as shown here are undergoing testing

Air sealing of buildings has resulted in substantially reduced energy consumption in most cases but it can create indoor pollution problems due to the concentration of certain gaseous substances within buildings. While air-to-air heat exchangers have been shown to be effective in controlling ventilation, there is a need to develop units having improved heat transfer characteristics. Using heat pipe technology, originally developed for satellites, prototype air-to-air heat exchangers have been designed and built in Alberta. They are compact, light weight, easily cleaned, have no moving parts other than fans, and offer the potential of improved and rapid heat transfer. Also, frost protection and summer cooling capabilities have been included, along with ventilation and humidity control. Four units have been built and are undergoing testing and monitoring.

Development of a Computer Program for Analysis of Thermal Mass in Buildings

The University of Calgary, Calgary

Optimal levels of energy conservation could be designed into new buildings if building scientists could estimate how energy loads are altered by changes in such factors as building geometry and construction materials. In particular, an ability to predict the thermal storage and radiant heating characteristics of masonry walls and floor slabs would be of considerable value at the design stage.

This project resulted in the development of a computer program which can estimate the effect of thermal mass on energy delivery and distribution with an accuracy greater than 95 per cent. In its original form, the program was so complex it required the use of a mainframe computer, but a refined version that can be run on a microcomputer is being developed to make the program readily accessible to engineers and designers.

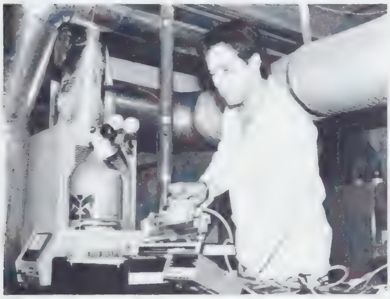
Survey of Energy-Efficient Furnaces

Howell Mayhew Engineering Inc., Edmonton

Approximately 25 per cent of all furnaces currently purchased by Albertans are medium- or high-efficiency, energy-conserving units. Because of their design and the way they are integrated into homes, some concerns have arisen that relate to corrosion, condensation, poor installation and servicing, high maintenance costs and diminished indoor air quality. This study is surveying home owners as well as furnace manufacturers, regulatory agencies and utilities to identify real, versus perceived, concerns and then it will provide some guidance to the industry in addressing those problem areas. Also, the findings should be useful to prospective furnace buyers.

Seasonal Efficiency of Residential Natural Gas Furnaces

University of Alberta, Edmonton



Compared with conventional furnaces, higher-efficiency gas-fired units save energy but payback periods are much longer

Natural gas furnace manufacturers have developed a variety of high-efficiency units in a general effort to reduce energy consumption in residential housing. This project's objective is to provide an independent and reliable measure of the seasonal efficiency of representative products now on the market. Six test furnaces were purchased and installed in two of the housing modules of the Alberta Home Heating Research Facility of the University of Alberta. During the 1983/84 to 1985/86 heating seasons, tests were conducted on an ICG Standard Unit, an ICG Conserver equipped with electronic ignition and a flue damper, an ICG Ultimate, Lennox Pulse Unit, an AIRCO induced draft unit and an externally installed AMANA unit which heats a water-glycol mixture and circulates it to the appropriate components inside the housing module. Both the ICG Ultimate and Lennox Pulse units are high-efficiency condensing furnaces.

Each furnace was tested for steady state efficiency, seasonal efficiency according to a proposed procedure of the Canadian Gas Association and seasonal efficiency from actual field experiments.

It was found that all of the furnaces performed as well as the manufacturers claimed. At 68 per cent seasonal efficiency, the ICG standard performed better than expected. Seasonal efficiency results for the others were: ICG Conserver, 75%; Airco, 83%; ICG Ultimate, 91%; AMANA, 95% and Lennox Pulse, 96%.

Test results showed that replacement of a standard furnace with a high-efficiency model will save energy but payback periods ranging from 6.5 and 7 years for the Airco and ICG Ultimate to 12 and 18 years for the Lennox Pulse and the AMANA must be anticipated. In regions where energy costs are higher than in Alberta, payback periods would be shorter.

Development of a User-Friendly Computerized Building Management System

MLW Interspace Management Ltd., Edmonton

INTEGRATION I building management system is easy to operate and is flexible enough to be used in buildings of various size

Although it has been demonstrated that maintenance and operating costs can be reduced, and energy can be saved, if the heating, ventilation and air conditioning systems of a building are properly managed and controlled, most of the existing computerized control systems are expensive and complicated because they have been developed primarily for large buildings. While some less expensive systems are available for small buildings, they lack flexibility.

This project was undertaken because it appears there is a need for an easy-to-use, inexpensive and reliable environmental control system that can be used in buildings of various size.

During fiscal year 1984/85 a prototype system called ''INTEGRATION 1'' was developed and bench tested. The system, based on readily available microprocessor technology, consists of a remote programmable controller and a control and monitoring station. The components can be interconnected by cable within a building or remotely over telephone lines.

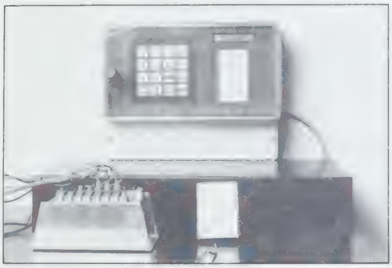
The modular concept used in the design allows monitoring and control of a large number of buildings by one remote control centre or the interconnection of up to 99 remote programmable controllers for very large applications.

In order to demonstrate the advantages of the system, it was installed in a 52 000 square foot City of Edmonton building in early December, 1985. The building contains office space, a warehouse area and a sizeable garage for municipal vehicles. During the three month demonstration period, the system controlled 18 unit heaters, seven roof-top heating and cooling units, five exhaust fans, one central heating, ventilation and air conditioning (HVAC) system and the electricity supplied to car plug-ins. From mid-December 1985 to mid-March 1986, when the building's mechanical and electrical systems were controlled by ''INTEGRATION 1'', natural gas consumption was reduced 40 to 50 per cent and electricity costs were down 39 per cent despite night time activities within the building which used more electricity than normal.

Because the computer uses ''menus'' and other interactive procedures to make the system more user-friendly than most other control systems, building operators were able to use it competently after only four hours of classroom instruction.

Multi-Zone Setback Thermostat

Daxcom Electronics Inc., Calgary



A multi-zone setback thermostat was developed which can achieve a two year payback by reducing demand for electricity

A new and different approach toward energy management within large buildings has been pursued by Daxcom Electronics Incorporated. The company developed an electronic thermostat/controller capable of controlling 16 independent heating or ventilation zones in an individual building or in building complexes. A marketing study, performed by the University of Calgary Business Action Research Group, indicates that a market exists for the product in buildings where pneumatically controlled ventilation and air conditioning systems have not been automated. Subsequently, the controller was modified and now it can be used for multi-zone temperature, ventilation and air conditioning control, as well as for controlling multiple roof-top heating units in commercial and industrial complexes.

A prototype unit has operated continuously in the laboratory for six months without hardware or software failures of any kind. Based on the amount of electrical energy that could be saved by using the device, its payback period is estimated to be less than two years. In retrofit situations, it is expected the device will have a price advantage of $500 per zone versus conventional methods of controlling cooling loads in buildings.

Because arrangements could not be made within the allotted time to demonstrate the unit in a suitable building, the project was terminated.

A New Heat-Conserving Control System for Warehouse-Type Buildings

Camcon Controls Ltd., Calgary

Cold air that enters a warehouse whenever overhead doors are opened during the winter can cause the heating system to turn on even though the air temperature is adequate elsewhere in the building. Consequently, it was postulated that control units that are interlocked with the door mechanism might permit some energy savings in the form of reduced fuel consumption. Prototype heat-conserving control units were installed at six warehouse locations. It was found that the original units were inadequate in their ability to provide the desired level of control. Subsequent modifications and testing showed results that varied widely. At four warehouse locations, fuel efficiency increased by three to 22 per cent, but at two warehouses it decreased by 12 and 18 per cent. The discrepancy could not be explained. The contractor feels the results suggest there is a market for his product. Careful targeting of the control unit should reveal those markets where it is most applicable.

Computer Simulations for Mechanical Systems in Buildings

Southern Alberta Institute of Technology, Calgary

Along with appropriate software, a low cost computer that uses color coded keys was developed to allow simulations of some major building mechanical systems

In recent years a number of energy-saving devices that control heating, ventilation and air conditioning systems have come on the market specifically for use in building management schemes. As their popularity has grown, so has the need to train people to operate them.

A series of graphical interactive computer simulations of four air handling systems commonly found in commercial and industrial buildings was developed at Southern Alberta Institute of Technology (SAIT). These simulations can be used to train new operators or help others upgrade their skills in properly controlling environmental conditions within buildings while achieving optimal energy efficiency and cost effectiveness. Simulations are run on a low cost computer system developed especially for this project that uses a simplified keyboard having only eight color coded keys. It is compact and portable and can be used by students who have no previous computer experience. Presently the system is being converted to allow the use of a standard cathode ray tube (CRT) system, thereby making it available to anyone with access to a television set.

Software is being developed to simulate: 1) a single duct, constant volume, variable temperature air handling system; 2) a single duct, constant temperature, variable volume air handling system; 3) a multi-zone, constant volume, variable temperature air handling system and 4) a dual duct, constant volume, variable temperature air handling system.

The material developed to date is ideal for use in outreach or distance-learning courses. The project is close to completion. SAIT staff plan to refine the simulations further and market the system to training institutions and building owners and managers.

Comprehensive Retrofit Measures in Commercial Buildings

Adept Engineering, Calgary

In climates that are not as extreme as Alberta's, energy conservation measures undertaken in commercial buildings have produced cost savings as high as 21 per cent. The objective of this investigation was to obtain comparable, Alberta-based data by identifying energy conservation measures appropriate for commercial buildings. The contractor would then obtain approval from a building owner to conduct a thermographic scan for air leakage and he would seal the building. This would be followed by a monitoring program to determine costs and subsequent benefits. Because approval to proceed with retrofit work was not granted by the owner of the proposed test building, the project was terminated after the technology review was completed. Discussions are continuing to locate a suitable demonstration building.

Retrofit Curtain for Overhead Doors

Appropriate Technology, Calgary

Air leakage around doors of any kind represents a substantial energy loss but overhead warehouse doors, in particular, are difficult to seal because of their design.

When this investigation began by reviewing existing technology, it was found that the idea of using a retrofit curtain on overhead doors was innovative and it had substantial commercial appeal.

After several prototype models were built, two full-size curtains were installed in a warehouse owned by the City of Calgary. Heat loss analysis and air leakage testing, performed on the warehouse before and after the curtains were installed, showed that the curtains were reducing natural gas consumption by 25 per cent more than conventional weatherstripping, and air leakage was reduced by 95 per cent, compared with 35 to 45 per cent when weatherstripping is used. This improvement led to the conclusion that a payback period of two to three years can be anticipated. During the next phase of the project the commercial potential of the product will be determined.

Energy Conservation in Public Swimming Pools

IBI Group, Calgary

Because indoor swimming pools are major energy consumers, they offer considerable potential for energy and cost savings.

Information regarding the design, energy consumption and operation practices was reviewed for 12 City of Calgary public pools. A detailed evaluation of energy conserving measures was carried out at the Renfrew Swimming Pool. It revealed that several low cost or no cost retrofit measures were appropriate in this instance along with an overall retrofit of the building skin. A building management system was installed and monitoring was begun in anticipation that the findings would be applicable to pools throughout Alberta.

Swimming Pool Dehumidification Demonstration

Klass Mechanical Enterprises Ltd., Calgary

Usually, the air surrounding an indoor swimming pool is very humid because considerable quantities of water vapor are released from the surface of the water. At the same time, significant quantities of energy are used to raise the pool temperature to certain desired levels. Preliminary investigations indicate that refrigeration-type dehumidifiers can be used in swimming pool facilities to produce comfortable surroundings by reducing humidity. The effectiveness of such systems will be demonstrated at the University of Lethbridge in the next phase of this investigation.

A low emissivity ceiling was installed in the Londonderry Arena in Edmonton

Demonstration of Low Emissivity Ceilings in Alberta Arenas

Sunton Engineering Ltd., Edmonton

In an indoor ice arena, heat is radiated (or emitted) from the relatively warm ceiling to the comparatively cold ice surface. This causes the ice surface temperature to rise and forces the arena ice plant to consume energy while removing the unwanted heat.

In the mid-1970s, a reflective aluminum ceiling material which emits less radiative heat was tried in several U.S. ice arenas, followed by trials in Ontario. It reduced energy costs by 20 to 30 per cent.

In this particular investigation it is proposed that low emissivity ceilings be installed at arenas in Edmonton and Medicine Hat. Approval was given to proceed with the retrofits. They will be monitored during fiscal year 1986/87.

A programmable controller was developed to control the amount of electricity supplied to vehicle plug-ins

Programmable Controller for Parking Lot Block Heater Service

MAGNA IV Engineering Ltd., Edmonton

Automobile block heaters and interior car warmers are used by a substantially larger percentage of Alberta motorists (95 per cent and 54 per cent respectively) than in the rest of Canada where, on average, only 27 per cent of all drivers use plug-in block heaters and eight per cent use interior warmers.

Studies have shown that even at -35°C it takes only three hours for a block heater to raise the engine coolant temperature high enough for an engine to start with ease. Nevertheless, at most outdoor parking lots power is supplied continuously to plug-in outlets. Consequently, many automobile block heaters and warmers draw more power than they need.

An alternative would be to supply power intermittently but a simple ''on'', ''off'' sequence would be inadequate because the length of the ''on'' cycle must change with ambient temperature and provision must be made for the fact that large numbers of vehicles may be in the lot for extended periods during certain times, while at other times vehicles may be parked for shorter periods.

In this investigation the contractor designed and built a programmable controller and also devised a control scheme for a 400 car parking lot at the University of Lethbridge. The controller switched on the power whenever the ambient temperature fell below 0°C and it altered the length of the ''on'' cycle as the temperature became colder. Also, it was programmed to be ''on'' for shorter periods after 7:00 p.m. During a test period in February 1986, energy consumption data showed that energy cost savings of $7000 per year are possible at the University of Lethbridge. This is enough to achieve a payback period of two years.

Demonstration of a Cost-Effective Energy Management System

Whitaco Holdings Ltd., Edmonton

A low cost micro-processor was used to control energy consumption in a commercial building. After installation, the micro-processor controlled 10 natural gas-fired furnaces for two years, during which time natural gas consumption was reduced by 26 per cent. The project has been completed.

Demonstration of Mini-Fluorescent Lighting

Clear-View Lighting Ltd., Calgary

Now that mini-fluorescent lamps are available, it is possible to use them in applications where, previously, incandescent lamps were the only choice

For years, fluorescent lighting has been used in place of incandescent in commercial and institutional buildings because fluorescent lamps provide greater light output and have a longer life. Until recently, however, incandescent lamps were still used in emergency lighting, in Exit signs and in certain ''downlighting'' situations because fluorescent lamps small enough for these applications were not available. Recently, however, mini-fluorescent lamps have become available. Consequently, this study was initiated to develop small fluorescent fixtures that could directly replace incandescent ones without having to modify the existing wiring. To determine the performance and cost effectiveness of the mini-fluorescent fixtures, they were to be used in place of incandescent units in selected corridor, storage area and stairwell lighting locations at Foothills Hospital in Calgary as well as to replace all incandescent lamps in the hospital boiler plant.

Initial surveys indicated that cost savings were possible, as long as lamp operation was continuous, despite higher fixture and lamp costs of fluorescent versus incandescent systems. Furthermore, it was shown that mini-fluorescents are cost effective for many applications. However, the contractor was unable to proceed with a practical demonstration at Foothills Hospital to support these contentions because lighting level guidelines for the hospital's corridors could not be met. Presently the contractor is assessing particular applications in a variety of commercial buildings.

Demonstration of Free Cooling in Building Humidification Systems

Safronek, Pomeroy & Associates Ltd., Calgary

Air conditioning systems perform two functions: they lower the ambient air temperature by means of refrigeration and they raise the relative humidity by supplying water vapor which has been evaporated from water-soaked pads or been distributed by spray nozzles. Under some atmospheric conditions, evaporation alone will produce sufficient cooling to achieve an acceptable level of indoor comfort. When this is possible, the refrigeration unit is not required and can be shut off. This can result in energy savings.

A review of Alberta's temperature and humidity conditions, along with knowledge of operating practices in office buildings, schools and industrial plants suggests that evaporative cooling is technically feasible throughout the province with particular relevance to southern Alberta. This technology will be evaluated at the University of Lethbridge.

Peak Electrical Demand Reduction Through Co-generation

Cheriton Engineering Ltd., Calgary

Electric power companies base their charges on the maximum demand that a customer has for electricity over a specified period. Therefore, an effective way to lower utility costs is to reduce ''peak demand'' for electricity. Because most large buildings already have an emergency generator on site, it is proposed that the generator could be used in non-emergency situations to generate some of the electricity needed in a building, and thereby reduce peak demand. Furthermore, if heat is recovered from the generator and it is used to offset heat from other sources, energy costs may be further reduced and the overall efficiency of the engine-generator could be raised to 75 to 80 per cent rather than 30 to 40 per cent if it is used only to generate power. This project is examining the cost effectiveness and energy efficiency of using an existing emergency generating system at the University of Lethbridge for peak demand reduction.

Using an existing emergency generator to shave peak electricity demand may prove to be cost effective

Wind Energy

Demonstration and Testing of Small-Scale Wind Turbines

Alberta Agriculture, Lethbridge

Of all the wind pumps studied at the Lethbridge test site, the Deltx WP-20 appears to be the most productive

Since 1982, A/CERRF has been funding performance testing studies of water-pumping wind turbines at a specially-constructed site in Lethbridge. The work has focused on such machine characteristics as performance under varying wind conditions, water pumping rates, survivability, maintenance requirements and frequency of breakdowns. To date, equipment manufacturers and prospective buyers have shown considerable interest in the project and, as a result, the testing program was extended for another three year period.

To improve data acquisition from machines at the site a new computer system based on an IBM-PC was installed. It has proven to be more efficient and it requires less maintenance than the previous system.

During the previous three year test period, the test site and the turbines were shut down during the winter but this year an attempt was made to operate two water-pumping turbines under winter conditions. Although the cold weather contributed to long delays whenever mechanical difficulties were experienced, enough data were obtained for one of the machines, a Deltx WP-20, designed and built in Calgary, to indicate that it can outperform any of the wind turbines tested so far in terms of annual volume of pumped water, maximum pumping volume and annual volume pumped per square foot of swept area. The other machine, a Chinook multi-bladed turbine manufactured in Calgary from a British design, failed to produce any performance results because problems that arose with the rotor assembly and pump apparatus were not solved. The contractor concluded that winter operation of these turbines was too difficult and expensive and, therefore, future winter use should be avoided.

Meanwhile, 200 copies of a report describing results from the previous three-year program were distributed widely. Additional demand for the document is high enough to justify a second printing. In both Alberta and Saskatchewan, sales of wind turbines have increased as a direct result of the program and manufacturers have received enquiries from other countries on the basis of published accounts of the earlier tests.

A Large Delta-Blade Wind Turbine, an Alberta Development

Deltx Windpump Corporation, Calgary

Development and testing of a family of delta-blade wind turbines continued from previous years. These machines are designed to pump water at variable wind speeds for a variety of purposes. Based on a design by Professor J.A.C. Kentfield of the University of Calgary, the turbine was initially developed by Abax Energy Services Ltd. and, since the beginning of 1984, by the newly formed Deltx Windpump Corporation, both of Calgary, with significant funding by A/CERRF.

During 1985/86, performance testing of the large, 16-metre diameter prototype unit was delayed due to leaks in the associated water pump valves and less than optimal response by the variable stroke control mechanism, which allows the turbine to pump water at or near its maximum efficiency.

Subsequently, the pumps have been repaired and a faster responding stroke control system has been installed. This eliminated some of the difficulties but the variable stroke mechanism continues to be a problem.

Nevertheless, by manually simulating the effects of the variable stroke control system, performance testing was done at a head of 4.4 metres (14 feet) and at wind speeds below 10 m/s (22mph). The unit began pumping at a wind speed of 2.2 m/s (5mph) and by 8 m/s (18mph) was pumping at a rate of 180 l/s (40 gallons/sec).

Meanwhile, testing of the smaller WP-20 machine has shown results that were sufficiently promising to encourage purchase of one unit by the Navajo Nation in the U.S. with prospects of 100 additional sales.

Because the turbine technology can be used to pump water in irrigation systems, to establish suitable marshes and habitat for waterfowl and allow storage of water for hydropower systems, there is considerable interest in this family of windpumps from within Canada and abroad.

Solar and Wind Energy Research Program (SWERP)

Alberta Research Council, Edmonton

After the SWERP program was completed, monitoring equipment was donated to agencies having ongoing programs in renewable energy

Following completion of the field work portion of SWERP during 1984/85, gathered data were processed and evaluated. It was concluded that the program had achieved its objectives of providing a detailed assessment of Alberta's solar and wind energy resources and, therefore, continuation of the program was not warranted. Monitoring instrumentation used at all seven SWERP stations was donated to agencies having ongoing programs in the renewable energy field. They included Alberta Research Council, the Atmospheric Environment Service of Environment Canada and the departments of Mechanical and Electrical Engineering at University of Alberta.

Meanwhile, the activities of the SWERP Information Centre were wound up on the recommendation of an independent consultant who assessed the need for ongoing A/CERRF support and concluded it was not required. Subsequently, the library collection of 9100 books and periodicals was transferred to the University of Alberta Science and Technology Library where extended open hours could allow easier public access to the information. Concurrently, the SWERP bibliographic database, which is stored on magnetic tape and contains about 8000 references, was transferred to University of Alberta Computing Services where it continues to be available to the public.

Waste Heat Recovery

Grey Water Heat Recovery From Commercial Laundries

Adept Engineering, Calgary

The temperature of effluent water from commercial laundries is sufficiently high that it seems likely heat can be recovered from it in energy conservation schemes that could have wide application. Initial investigations have confirmed this hypothesis. Retrofit equipment was in the process of being installed at two Calgary laundries to determine the advantages of such an approach. Preliminary calculations indicate that payback periods of three years are likely, based on energy savings and the ability to reuse water that was previously discharged to the sewer.

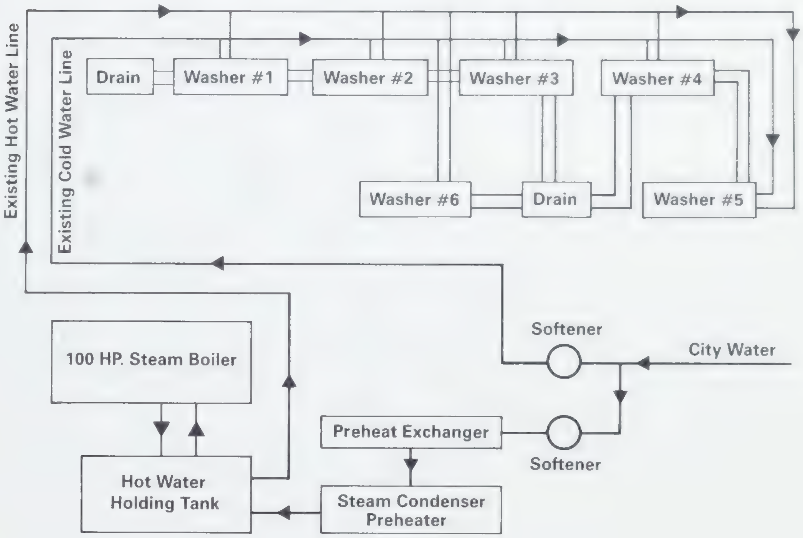


Figure 2: Grey Water Heat Recovery
In a commercial laundry, where operations can be described by this schematic drawing, heat can be recovered from the grey water which presently is discharged to the sewer

Heat Recovery in a Full Service Dairy

Palm Dairies Ltd./Crawford Consulting Engineering Ltd., Calgary

A detailed analysis of a Calgary dairy to identify sources of waste heat and opportunities to reuse it became more difficult than anticipated due to the complex nature of the facility. In particular, the determination of accurate flow rates and heat balances required additional metering and monitoring. A design for a heat recovery system has been completed and the preparation of tender documents is underway.

Heat Recovery in a Meat Packing Plant

Lakeside Feeders Ltd., Brooks
Crawford Consulting Engineering Ltd., Calgary

Waste heat recovery from "cold" rooms in a meat packing plant is being investigated in this study as one way to preheat water used elsewhere in the meat preparation process. Initial investigations revealed that purchase and installation of heat recovery equipment should result in enough energy savings to pay back costs within two years. Equipment purchase is essentially complete. It will be followed by installation and monitoring for several months.

Heat Recovery in a Recreation Facility

Kasten Eadie Engineering Ltd., Edmonton

In multi-purpose recreation facilities, it is commonplace to find a skating rink in one portion of the building and a swimming pool in another. While the process of making ice for the rink involves heat removal, water used in the pool must be heated to approximately 30°C. Therefore, it is practical to consider some means of recovering waste heat from one operation and using it in the other, as well as for space heating purposes to reduce the overall electrical load in the facility. Based on an assessment of the concept in general terms, a detailed analysis of the proposed test facility, the Okotoks Triplex Arena, has been made. The contractor and the Town of Okotoks are negotiating with the supplier of retrofit equipment to proceed with an installation. This will be followed by performance monitoring.

Co-generation Demonstration in Commercial Buildings

Northwestern Utilities Limited, Edmonton

At a time when consumers of electricity are being urged to reduce their demand for electric power, and as industries and the public alike respond by implementing energy conservation programs, it is difficult for electric power companies to justify the costs of building new and expensive electricity generating stations. One flexible alternative that may appeal to owners of commercial buildings and institutions is to install co-generation equipment to produce electricity on site and to recover and reuse heat from the generator. Northwestern Utilities initiated an evaluation of co-generation technology and a survey was made of buildings that might be suitable demonstration sites. The contractor intends to install a co-generation unit in a commercial building and monitor its performance for one year, as well as determine the extent of economic benefits.

Co-generation Assessment Study

Southern Alberta Institute of Technology, Calgary

The cost-effectiveness of co-generating systems is the subject of a study

Simultaneous production of electricity and recoverable heat in engine generators may have wide application in Alberta buildings, institutions and industry. To determine the merits of co-generation and its prospects in Alberta as well as its costs and benefits, a survey is underway of equipment manufacturers, users and utility companies.

Utilization of Waste Heat for Crop Production

C.W. Reclamation Ltd., Olds

In many industrial processes, water that is used for cooling purposes absorbs heat to such a degree that it cannot be released into lakes and streams until it is first cooled, usually in some type of cooling tower. One alternative to this practice would be to distribute warm water through a system of pipes to nearby farm land and thereby transfer heat to the soil. This can extend the growing season and enhance crop production. A one hectare test plot adjacent to Petro-Canada's Empress plant has been chosen to demonstrate the concept of ground heating. A computer analysis of heat transfer in soil reveals that ambient air temperature, soil type, moisture content and pipe spacing are the factors most likely to affect performance. Subject to positive results from the detailed feasibility and analysis study in this phase of the project, a ground heating system may be installed in the test plot and monitored.

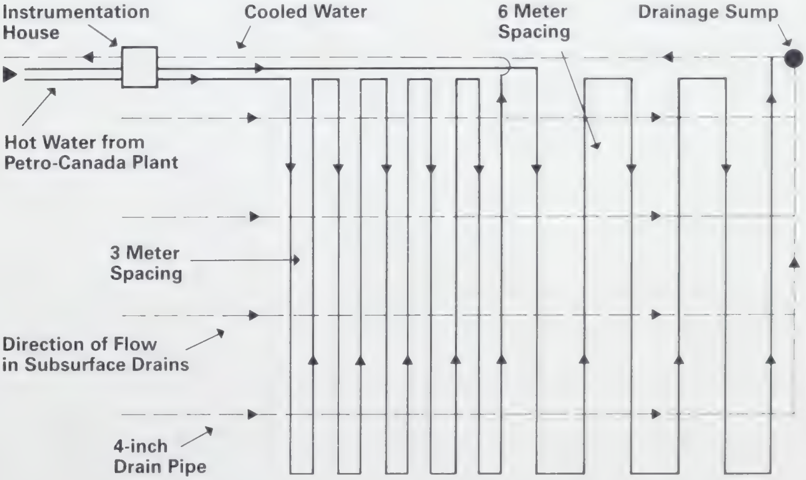


Figure 3: Waste Heat for Crops

A proposed network of subsurface pipes, carrying warm waste water from a Petro-Canada plant to adjacent agricultural land, would transmit heat to the surrounding soil in an attempt to improve crop yields and extend the length of the growing season

Technology Transfer

Technology Transfer and Dissemination

MacKenzie Environmental Consultants Ltd., Edmonton

Approximately 28 technology transfer booklets will be written in order to summarize the pertinent findings of 100 research projects supported by A/CERRF since the fund was created in 1976. The booklets will be distributed to researchers and others who are best able to use the information. Seven booklets were written and three were published during the fourth quarter of the year.

Results of A/CERRF-funded studies are summarized in technology transfer publications which are then distributed to industry and others who are best able to use the information

Appendices

In the following section, financial information on this year's projects, as well as sums expended to date on all A/CERRF-funded energy conservation and renewable energy projects, can be found in Appendix A.

Research reports that have resulted from some of these investigations, and are available for viewing at Alberta Energy's library in Edmonton, are listed in Appendix B.

Appendix A: Summary of Program Expenditures

A/CERRF Energy Conservation and Renewable Energy Projects and Expenditures to Date

	Fiscal Year(s) 1977-1982	1982-83	1983-84	1984-85	1985-86	Projected Future Funding	Projected Total Funding Contribution
General Energy Conservation							
Control of Energy Losses by Microbial Fouling of Heat Exchangers	94 795	-	-	-	-	-	94 795
Ice Nucleation Technique for Defouling Heat Exchangers	75 459	3 799	-	-	-	-	79 258
Using Thermal Discharges from Power Plants	15 000	-	-	-	-	-	15 000
Fuel and Fertilizer Production from Dairy Manure	23 324	-	-	-	-	-	23 324
Efficient Use of Low Heating Value Fuels	59 677	143	-	-	-	-	59 820
Streamline Device for Transport Trucks	8 916	-	-	-	-	-	8 916
Energy from Waste Wood (Sawmill Residue)	114 501	-	-	-	-	-	114 501
Efficiency of Rotary Piston Engine	11 857	-	-	-	-	-	11 857
District Heating Study	93 400	-	-	-	-	-	93 400
Energy Conservation in Sour Gas Processing	918 574	34 963	93 637	131 399	-	-	1 178 573
Solar Energy							
Copper-Oxide Solar Cells	28 870	-	-	-	-	-	28 870
An Atlas of Solar Energy for Alberta	44 629	-	-	-	-	-	44 629
Application of Boiling and Condensation Heat Transfer for Flat Solar Collectors in Cold Regions	86 223	12 977	-	-	-	-	99 200
An Air-Mediated Solar Heating System with Long-Term Storage	42 613	-	-	-	-	-	42 613
An Advanced Control Approach for Solar Heating Systems	10 219	3 082	-	540	-	-	13 841
Geothermal Energy							
Research on Alberta's Geothermal Energy Resources	196 775	83 875	57 560	-	-	-	338 210
Fusion Energy							
Laser Fusion Energy Research	329 745	152 927	148 035	-	-	-	630 707
Energy Conservation in Buildings							
Alberta Home Heating Research Facility	224 260	19 258	266	-	-	-	243 784
Insulation Properties of Flat Built-Up Roofs	47 957	7 980	-	-	-	-	55 937
Passive Solar-Heated Community Centre	12 170	2 000	-	-	-	-	14 170
Energy-Efficient Masonry Fireplaces	-	48 820	-	-	-	-	48 820
Edmonton Energy Conservation Centre	-	-	-	51 920	25 000	-	76 920
Self-Help Retrofit Manual for Owners of Multi-Family Housing Units	-	-	1 744	12 806	10 850	-	25 400
Retrofit Wall Systems for Residential Housing	-	-	342	2 540	6 998	-	9 880
Energy Savings and Payback of Retrofit Basement Wall Insulation	-	-	506	8 435	3 883	826	13 650
Energy-Efficient Housing Display Program	221 332	3 614	7 384	1 670	-	-	234 000
Townhouse Retrofit Demonstration	-	-	6 477	11 048	2 514	-	20 039
A Survey of Air Leakage in Alberta Homes	-	-	15 709	40 071	4 376	-	60 156
Construction and Testing of a Masonry Module	-	-	9 931	14 750	5 896	-	30 577
Concrete Masonry Walls for Thermal Storage, Heating and Insulation	-	-	5 861	10 440	-	-	16 301
Sizing of Warm Air Furnaces for Residential Use	-	-	3 192	127	-	-	3 319
Computer Program for Analysis of Thermal Mass	-	-	-	-	24 314	1 641	259 525
Development of Higher-Efficiency Gas-Fired Furnaces	-	-	4 376	35 624	30 000	-	70 000
Seasonal Efficiency of Residential Natural Gas Furnaces	-	-	-	20 261	12 738	2 651	35 650
Development of an Insulating Curtain for Residential Installation	-	-	8 047	25 917	-	-	33 964

	Fiscal Year(s) 1977-1982	1982-83	1983-84	1984-85	1985-86	Projected Future Funding	Projected Total Funding Contribution
Residential Air-to-Air Heat Exchanger Using Heat Pipe Technology		-	943	5 967	4 192	1 668	12 770
Energy Conservation in Public Swimming Pools			9 969	20 236	1 635		31 840
Development of a User-Friendly Computerized Building Management System	-	-	4 928	37 281	26 914	901	70 024
Multi-Zone Setback Thermostat	-	-	8 359	28 553	4 048	40 960	
A New Heat-Conserving Control System for Warehouse-Type Buildings	-	-	3 538	17 782	9 654		30 974
Demonstration of a Cost-Effective Energy Management System	-	-	8 427	8 359	-		20 324
A Ventilation Control System Based on Carbon Dioxide Levels	-	-	604	750	-	-	1 354
Inventory of Building Design and Analysis Computer Programs and a Weather Input Data Base for Alberta	-	-	1 484	35 681	382	-	37 547
Energy-Efficient Fluorescent Lighting Ballast	-	-	19 565	30 372	-		49 937
Computer Simulations for Mechanical Systems in Buildings	-	-	8 886	27 885	11 537		48 308
Programmable Controller for Parking Lot Block Heater Service	-	-	-	-	8 210		8 210
Comprehensive Retrofit Measures in Commercial Buildings	-	-	-	-	14 552	-	14 552
Retrofit Curtain for Overhead Doors	-	-	-	-	13 656	3 696	13 656
Demonstration of Mini-Fluorescent Lighting	-	-	-	-	2 700	3 235	5 935
Survey of Energy-Efficient Furnaces	-	-	-	-	20 282	14 168	34 450
Swimming Pool Dehumidification Demonstration	-	-	-	-	4 700	7 500	12 200
Peak Electrical Demand Reduction Through Co-generation	-	-	-	-	5 745	18 091	23 836
Demonstration of Free Cooling in Building Humidification Systems	-	-	-	-	2 600	30 970	3 570
Demonstration of Low Emissivity Ceilings in Alberta Arenas	-	-	-	-	8 102	30 746	38 848

Wind Energy

	Fiscal Year(s) 1977-1982	1982-83	1983-84	1984-85	1985-86	Projected Future Funding	Projected Total Funding Contribution
Comparison of Wind Turbines	10 686	14 310	-	-	-	-	24 996
Demonstration and Testing of Small-Scale Wind Turbines	-	72 386	47 324	34 408	61 974	87 026	303 118
Solar and Wind Energy Research	1 573 307	233 699	254 195	230 179	179 950	-	2 471 330
A Large Delta-Blade Wind Turbine, an Alberta Development	92 945	170 400	477 772	35 294	106 908	41 092	924 411

Waste Heat Recovery/Low Temperature Heat Utilization Subprogram

	Fiscal Year(s) 1977-1982	1982-83	1983-84	1984-85	1985-86	Projected Future Funding	Projected Total Funding Contribution
Grey Water Heat Recovery from Commercial Laundries	-	-	-	-	36 906	47 144	84 050
Heat Recovery in a Recreation Facility	-	-	-	-	5 707	-	5 707
Heat Recovery in a Meat Packing Plant	-	-	-	-	10 500	61 839	72 239
Heat Recovery in a Full Service Dairy	-	-	-	-	-	7 000	23 900
Co-generation Demonstration in Commercial Buildings	-	-	-	-	1 267	103 184	104451
Co-generation Assessment Study	-	-	-	-	14 758	65 242	80 000
Utilization of Waste Heat for Crop Production	-	-	-	-	16 395	-	16 395
TOTAL — Energy Conservation and Renewable Energy Projects	**4 337 234**	**864 233**	**1 209 061**	**880 298**	**699 843**	**569 580**	**8 698 538**

Appendix B: Publications List

The following project reports, prepared by contractors whose investigations were supported by A/CERRF, are available for viewing at:

Alberta Energy Library
9th Floor, South Tower, Petroleum Plaza
9915 - 108 Street
Edmonton, Alberta
T5K 2C9
Telephone: (403) 427-7425

General Energy Conservation

Thermal Power Plant Waste Heat Utilization in Alberta: Potential and Problems, F.B. MacKenzie and A.H. Laycock, University of Alberta, 1979.

Fuel and Fertilizer Production from Dairy Manure, J.J.R. Feddes, J.B. McQuitty and J.T. Ryan, University of Alberta, March 1980.

The Efficient Utilization of Low Heating Value Fuels, G.A. Karim, University of Calgary, January 1982.

A Streamline Device for Trucks and Buses, R.P. McKenzie, 1982.

Claus Plant Waste Gas Incinerators, Western Research and Development, July 1978.

Catalytic Incineration of Sulphur Plant Waste Gases, Bow Valley Research Ltd., February 1981.

Recuperative Heat Exchange Incinerator Pilot Plant, Bow Valley Research Ltd., October 1981.

Study on Energy and Chemicals from Wood, SNC Tottrup Services Ltd., 1979.

Edmonton District Heating Study — Financial Feasibility, Stanley Associates Engineering Ltd./Ekono Engineering Consultants, February 1980.

Solar Energy

A Solar Energy Atlas for Alberta, Volumes I and II, L.C. Nkemdirim, University of Calgary, September 1981.

Application of Boiling and Condensation Heat Transfer to Flat Plate Solar Collectors in Cold Regions, K.C. Cheng, University of Alberta, August 1982.

Study of Air-Mediated Solar Heating Systems with Long-Term Storage, A.M. Robinson, University of Alberta, April 1981.

A Study of Improved Control Strategies for Bilinear Heat Transfer Processes in a Solar-Assisted Heat Pump System, R.E. Rink and H.Q. Le, University of Alberta, October 1982.

Geothermal Energy

An Investigation of Geothermal Energy Resources of Alberta, F.W. Jones, H.L. Lam and T.N. Nasr, University of Alberta, October 1981.

A Detailed Study of Regions of Geothermal Energy Potential in Alberta, F.W. Jones, H.L. Lam, M. Rahman and D. Yuen, University of Alberta, October 1982.

A Preparatory Study for Application of Geothermal Energy in the Hinton/Edson Area of Alberta, F.W. Jones, M. Rahman, H.L. Lam and J.E. Sworder, University of Alberta, October 1983.

Fusion Energy

CO_2 Laser Heated Solenoid Research and High Power Krypton Fluoride Laser Development for Fusion Energy Research, A.A. Offenberger, D.C.D. McKen and R. Fedosejevs, University of Alberta, May 1981.

High Power Krypton Fluoride Laser Development for Fusion Energy Research, A.A. Offenberger, D.C.D. McKen and R. Fedosejevs, University of Alberta, May 1983.

Energy Conservation in Buildings

Second Annual Report on the Alberta Home Heating Research Facility: Results for the 1980-81 Heating Season, R.R. Gilpin, T.W. Forest, M.Y. Ackerman, D.G. Wilson, G.W. Sadler, J.D. Dale and M. Zaheeruddin, University of Alberta, June 1981.

A Simulation Model for a Direct Gain Passive House and its Experimental Verification, M. Zaheeruddin, University of Alberta, April 1983.

A Study of Residential Housing Envelope Heat Losses, M.Y. Ackerman, University of Alberta, April 1983.

The Attachment of Insulation to Existing Built-Up Roofs, Alberta Roofing Contractors, August 1981.

A Project to Build and Display Energy Efficient Single Family Homes in Alberta, HUDAC Alberta Council, November 1982.

Report on the Selection of Warm Air Furnaces for Residential Housing, J.E. Sworder Engineering, November 1984.

Report on Inventory of Computer Programs, Vinto Engineering Ltd., December 1984.

Report on Development of an Alberta Weather Input Data Base, Vinto Engineering Ltd., February 1985.

R&D of an Insulating Curtain for Residential Application, Sunergy Systems Ltd., April 1985.

Controller for Parking Lot Block Heater Services, Phase I, MAGNA IV Engineering Ltd., November 1985.

Demonstration of Low Emissivity Ceilings in Arenas, Phase I, Sunton Engineering Ltd., April 1986.

Wind Energy

Evaluation of Low Volume Wind Turbines for Pumping Water, B.A. Paterson, D.R. Baker and N.E. Jensen, 1985.

Comparison Study of Wind Turbines, The Dalcor Group, April 1982.

Waste Heat Recovery

Waste Heat Recovery in a Meat Packing Plant, Phase I, Crawford Consulting Engineering Ltd., December 1985.

Technology Transfer

The following publications summarize the principal research results of some projects funded by A/CERRF. They are available from:

Alberta Energy Information Centre

Main Floor, Bramalea Building
9920 - 108 Street
Edmonton, Alberta
T5K 2M4

Telephone: (403) 427-3590

A Thermographic Detection System for Pipeline Leaks, 6 pages, March 1986.

Solar Energy Potential for Alberta, 9 pages, March 1986.

A Practical Method for Defouling Heat Exchangers, 6 pages, March 1986.

Additional copies of this review are available from:

Alberta Energy Information Centre
Main Floor, Bramalea Building
9920 - 108 Street
Edmonton, Alberta, Canada
T5K 2M4

Telephone: (403) 427-3590

Detailed information on any project funded by the Alberta/Canada Energy Resources Research Fund is available from:

Director
Energy Conservation and Renewable Energy Research
Scientific and Engineering Services and Research Division
Alberta Energy
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10909 Jasper Avenue
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Services and Research Division